

# THE ASTROPHYSICAL JOURNAL

Founded in 1895 by George E. Hale and James E. Keeler

ROBERT C. KENNICUTT, JR.

*Editor-in-Chief*  
Steward Observatory  
University of Arizona

CHRISTOPHER SNEDEN

*Letters Editor*  
University of Texas

JAMES W. LIEBERT

*Associate Editor-in-Chief*  
Steward Observatory  
University of Arizona

JOHN SCALO

*Deputy Letters Editor*  
University of Texas

## *Scientific Editors*

TIMOTHY BASTIAN  
National Radio  
Astronomy Observatory

W. B. BURTON  
University of Leiden &  
National Radio Astronomy  
Observatory

BRIAN CHABOYER  
Dartmouth College

KATIA FERRIERE  
Observatoire  
Midi-Pyrenees

BRAD GIBSON  
Swinburne University

DIETER HARTMANN  
Clemson University

ERIC HERBST  
Ohio State  
University

JOHN T. MARISKA  
Naval Research  
Laboratory

JUDITH PIPHER  
University of  
Rochester

JOSEPH C. SHIELDS  
Ohio University

SUSAN M. SIMKIN  
Michigan State  
University

LINDA S. SPARKE  
University of  
Wisconsin-Madison

LUIGI STELLA  
Osservatorio Astronomico  
di Roma

PAULA SZKODY  
University of  
Washington

ETHAN T. VISHNIAC  
Johns Hopkins University

## AAS PUBLICATIONS BOARD

SUMNER STARRFIELD (2002–2005), *Chairperson*  
Arizona State University

PATRICK OSMER (2002–2004)  
Ohio State University

JANE C. CHARLTON (2002–2004)  
Penn State University

MICHAEL F. A'HEARN (2001–2004)  
University of Maryland

JOSEPH CASSINELLI (2004–2007)  
University of Wisconsin

RICHARD GREEN (2004–2007)  
NOAO

JUDITH KARPEN (2003–2006)  
Naval Research Laboratory

*Publication Director:* JULIE STEFFEN  
*Production Manager:* CAROLYN CHMIEL

*Publication Manager:* KERRY KROFFE  
*Chief Manuscript Editor:* ELIZABETH HUYCK

*Manuscript Editors:* THAD A. DORIA, PAUL RUICH, ERIC SHUTT, ROCHELLE COHEN LODDER,  
JEREMY HORSEFIELD, KERRY TUPPER, ALISON COMPTON, ED MARTIN, BRIAN ROBINSON, LAURIE THRASHER,  
ERICA GRIFFIN, AMY VAN STEE, JESSICA SENTERS LAW, ERIK GREGERSEN, DAVID JOHNSON, ELIZABETH SCHAEFER, AND PAUL OGILVIE  
*Production Staff:* CINDY GARRETT, CECILIA HILGEMAN, ANJELICA SLOAN,  
STEPHANIE NORFLEET, LUKE JENSEN, ANNIE NISULA, CHRISTOPHER ROGALA, AND TAMARA GHATTAS  
*Tucson Editorial Office:* JANICE SEXTON, TERESA BANKS, AND GREGORY SCHWARZ

VOLUME 603, PART 1

2004 MARCH 10

PUBLISHED BY THE UNIVERSITY OF CHICAGO PRESS FOR  
THE AMERICAN ASTRONOMICAL SOCIETY

© 2004 BY AMERICAN ASTRONOMICAL SOCIETY. ALL RIGHTS RESERVED.

PUBLISHED THREE TIMES A MONTH

---

COMPOSED BY SPI PUBLISHER SERVICES

PRINTED BY CAPITAL CITY PRESS

MONTPELIER, VERMONT, U.S.A.

THE ASTROPHYSICAL JOURNAL  
CONTENTS OF VOLUME 603, PART I

2004 MARCH 1, NUMBER 1

	Page
EVOLUTION OF THE CLUSTER CORRELATION FUNCTION <i>Neta A. Bahcall, Lei Hao, Paul Bode, &amp; Feng Dong</i>	1
ANISOTROPY IN THE DISTRIBUTION OF SATELLITE GALAXY ORBITS <i>Alexander Knebe, Stuart P. D. Gill, Brad K. Gibson, Geraint F. Lewis, Rodrigo A. Ibata, &amp; Michael A. Dopita</i>	7
CHEMICAL ENRICHMENT IN DAMPED Ly $\alpha$ SYSTEMS FROM HIERARCHICAL GALAXY FORMATION MODELS <i>Katsuya Okoshi, Masahiro Nagashima, Naoteru Gouda, &amp; Satoshi Yoshioka</i>	12
ACCELERATION OF ENERGETIC PARTICLES BY LARGE-SCALE COMPRESSIBLE MAGNETOHYDRODYNAMIC TURBULENCE <i>Benjamin D. G. Chandran &amp; Jason L. Maron</i>	23
ON THE OBSERVED RAPID MOTIONS IN EXTRAGALACTIC RADIO SOURCES <i>Geoffrey Burbidge</i>	28
AN X-RAY-SELECTED ACTIVE GALACTIC NUCLEUS AT $z = 4.6$ DISCOVERED BY THE CYDER SURVEY <i>Ezequiel Treister, Francisco J. Castander, Thomas J. Maccarone, David Herrera, Eric Gawiser, José Maza, &amp; Paolo S. Coppi</i>	36
LOW-LUMINOSITY ACTIVE GALACTIC NUCLEI AT THE HIGHEST RESOLUTION: JETS OR ACCRETION FLOWS? ©	42
<i>James M. Anderson, James S. Ulvestad, &amp; Luis C. Ho</i>	
CONSTRAINTS ON THE VERY HIGH ENERGY EMISSION FROM BL LACERTAE OBJECTS <i>D. Horan, H. M. Badran, I. H. Bond, P. J. Boyle, S. M. Bradbury, J. H. Buckley, D. A. Carter-Lewis, M. Catanese, O. Celik, W. Cui, M. Daniel, M. D'Vali, I. de la Calle Perez, C. Duke, A. Falcone, D. J. Fegan, S. J. Fegan, J. P. Finley, L. F. Fortson, J. A. Gaidos, S. Gammell, K. Gibbs, G. H. Gillanders, J. Grube, J. Hall, T. A. Hall, D. Hanna, A. M. Hillas, J. Holder, A. Jarvis, M. Jordan, G. E. Kenny, M. Kertzman, D. Kieda, J. Kildea, J. Knapp, K. Kosack, H. Krawczynski, F. Krennrich, M. J. Lang, S. Le Bohec, E. Linton, J. Lloyd-Evans, A. Milovanovic, P. Moriarty, D. Muller, T. Nagai, S. Nolan, R. A. Ong, R. Palladini, D. Petry, B. Power-Mooney, J. Quinn, M. Quinn, K. Ragan, P. Rebillot, P. T. Reynolds, H. J. Rose, M. Schroedter, G. H. Sembriski, S. P. Swordy, A. Syson, V. V. Vassiliev, S. P. Wakely, G. Walker, T. C. Weekes, &amp; J. Zweerink</i>	51
TRANSIENT RELATIVISTICALLY SHIFTED LINES AS A PROBE OF BLACK HOLE SYSTEMS <i>T. J. Turner, S. B. Kraemer, &amp; J. N. Reeves</i>	62
FAINT GALAXY POPULATION IN CLUSTERS: X-RAY EMISSION, cD HALOS, AND PROJECTION EFFECTS <i>Carlos A. Valotto, Hernán Muriel, Ben Moore, &amp; Diego G. Lambas</i>	67
CHAIN GALAXIES IN THE TADPOLE ADVANCED CAMERA FOR SURVEYS FIELD ©	74
<i>Debra Meloy Elmegreen, Bruce G. Elmegreen, &amp; Clara M. Sheets</i>	
GLOBULAR CLUSTER FORMATION IN M82 <i>S. J. Lipsy &amp; P. Plavchan</i>	82
M31's UNDISTURBED THIN DISK OF GLOBULAR CLUSTERS ©	87
<i>Heather L. Morrison, Paul Harding, Kathy Perrett, &amp; Denise Hurley-Keller</i>	
COSMIC STAR FORMATION HISTORY FROM LOCAL OBSERVATIONS AND AN OUTLINE FOR GALAXY FORMATION AND EVOLUTION <i>F. D. A. Harwick</i>	108
GLOBULAR CLUSTER ARCHAEOLOGY: HYDROGEN-BURNING NUCLEOSYNTHESIS AND EXTRA MIXING IN EXTINGUISHED STARS <i>Pavel A. Denissenkov &amp; Achim Weiss</i>	119
DISCOVERY OF ANOTHER PECULIAR RADIAL DISTRIBUTION OF BLUE STRAGGLERS IN GLOBULAR CLUSTERS: THE CASE OF 47 TUCANAE <i>Francesco R. Ferraro, Giacomo Beccari, Robert T. Rood, Michele Bellazzini, Alison Sills, &amp; Elena Sabbi</i>	127

	<i>Page</i>
DISCOVERY OF BLUE HOOK STARS IN THE MASSIVE GLOBULAR CLUSTER M54 <i>Alfred Rosenberg, Alejandra Recio-Blanco, &amp; Macarena García-Marín</i>	135
OGLE-2003-BLG-262: FINITE-SOURCE EFFECTS FROM A POINT-MASS LENS <i>Jaiyul Yoo, D. L. DePoy, A. Gal-Yam, B. S. Gaudi, A. Gould, C. Han, Y. Lipkin, D. Maoz, E. O. Ofek, B.-G. Park, &amp; R. W. Pogge (The <math>\mu</math>FUN Collaboration), A. Udalski, I. Soszyński, Ł. Wyrzykowski, M. Kubiak, M. Szymański, G. Pietrzyński, O. Szewczyk, &amp; K. Żebruń (The OGLE Collaboration)</i>	139
AN X-RAY STUDY OF THE SUPERNOVA REMNANT G18.95–1.1 <i>I. M. Harrus, P. O. Slane, J. P. Hughes, &amp; P. P. Plucinsky</i>	152
A NEW MODEL FOR COSMIC-RAY ION EROSION OF VOLATILES FROM GRAINS IN THE INTERSTELLAR MEDIUM <i>E. M. Bringa &amp; R. E. Johnson</i>	159
TURBULENT AMBIPOLAR DIFFUSION: NUMERICAL STUDIES IN TWO DIMENSIONS <i>Fabian Heitsch, Ellen G. Zweibel, Adrienne D. Slyz, &amp; Julien E. G. Devriendt</i>	165
MAGNETIC FIELD STRUCTURE AND STOCHASTIC RECONNECTION IN A PARTIALLY IONIZED GAS <i>A. Lazarian, Ethan T. Vishniac, &amp; Jungyeon Cho</i>	180
A SURVEY OF SiO 5 $\rightarrow$ 4 EMISSION TOWARD OUTFLOWS FROM LOW-LUMINOSITY PROTOSTELLAR CANDIDATES <i>Andy G. Gibb, John S. Richer, Claire J. Chandler, &amp; Chris J. Davis</i>	198
HOT H <sub>2</sub> O EMISSION AND EVIDENCE FOR TURBULENCE IN THE DISK OF A YOUNG STAR <i>John S. Carr, Alan T. Tokunaga, &amp; Joan Najita</i>	213
TOWARD GRAVITATIONAL WAVE SIGNALS FROM REALISTIC CORE-COLLAPSE SUPERNOVA MODELS <i>Ewald Müller, Markus Rampp, Robert Buras, H.-Thomas Janka, &amp; David H. Shoemaker</i>	221
A CLOSE LOOK AT THE STATE TRANSITIONS OF GALACTIC BLACK HOLE TRANSIENTS DURING OUTBURST DECAY © <i>E. Kalemci, J. A. Tomsick, R. E. Rothschild, K. Pottschmidt, &amp; P. Kaaret</i>	231
FINAL PRODUCTS OF THE $\eta$ -PROCESS ON ACCRETING NEUTRON STARS <i>Osamu Koike, Masa-aki Hoshimoto, Reiko Kuromizu, &amp; Shin-ichirou Fujimoto</i>	242
UNSTABLE NONRADIAL OSCILLATIONS ON HELIUM-BURNING NEUTRON STARS <i>Anthony L. Piro &amp; Lars Bildsten</i>	252
BARE QUARK STARS OR NAKED NEUTRON STARS? THE CASE OF RX J1856.5–3754 <i>Roberto Turolla, Silvia Zane, &amp; Jeremy J. Drake</i>	265
THE ROCHE PROBLEM: SOME ANALYTICS <i>Zakir F. Seidov</i>	283
AN ERROR ANALYSIS OF THE GEOMETRIC BAADE-WESSELINK METHOD <i>Massimo Marengo, Margarita Karovska, Dimitar D. Sasselov, &amp; Mayly Sanchez</i>	285
INDIVIDUAL AND AVERAGE BEHAVIOR OF PARTICLES IN A PROTOPLANETARY NEBULA <i>P. Garaud, L. Barrière-Fouchet, &amp; D. N. C. Lin</i>	292
HELMET STREAMERS GONE UNSTABLE: TWO-FLUID MAGNETOHYDRODYNAMIC MODELS OF THE SOLAR CORONA <i>Eirik Endeve, Thomas E. Holzer, &amp; Egil Leer</i>	307
THE INABILITY OF STEADY-FLOW MODELS TO EXPLAIN THE EXTREME-ULTRAVIOLET CORONAL LOOPS <i>S. Patsourakos, J. A. Klimchuk, &amp; P. J. MacNeice</i>	322
SOLAR FAST-WIND REGIONS AS SOURCES OF SHOCK ENERGETIC PARTICLE PRODUCTION <i>S. W. Kahler</i>	330
IMPULSIVE AND GRADUAL NONTHERMAL EMISSIONS IN AN X-CLASS FLARE <i>Jiong Qiu, Jeongwoo Lee, &amp; Dale E. Gary</i>	335
MAGNETIC FIELD–MINIMUM INTENSITY CORRELATION IN SUNSPOTS: A TOOL FOR SOLAR DYNAMO DIAGNOSTICS <i>Aimee A. Norton &amp; Peter A. Gilman</i>	348
TESTS OF STATISTICAL SIGNIFICANCE AND BACKGROUND ESTIMATION IN GAMMA-RAY AIR SHOWER EXPERIMENTS <i>R. Fleischer, L. Fleischer, P. Nemethy, A. I. Mincer, &amp; T. J. Haines</i>	355
ERRATUM: “CLONING DROPOUTS: IMPLICATIONS FOR GALAXY EVOLUTION AT HIGH REDSHIFT” (ApJ, 593, 640 [2003]) <i>Rychard Bouwens, Tom Broadhurst, &amp; Garth Illingworth</i>	363
INSTRUCTIONS TO AUTHORS	i

2004 MARCH 10, NUMBER 2

OBSERVATIONAL CONSTRAINTS ON COSMOLOGY FROM THE MODIFIED FRIEDMANN EQUATION <i>Zong-Hong Zhu, Masa-Katsu Fujimoto, &amp; Xiang-Tao He</i>	Page 365
TESTING THE COSMIC MICROWAVE BACKGROUND DATA FOR SYSTEMATIC EFFECTS © <i>Louise M. Griffiths &amp; Charles H. Lineweaver</i>	371
THE FORMATION OF THE FIRST STARS. I. MASS INFALL RATES, ACCRETION DISK STRUCTURE, AND PROTOSTELLAR EVOLUTION <i>Jonathan C. Tan &amp; Christopher F. McKee</i>	383
PROTOSTELLAR DISK DYNAMOS AND HYDROMAGNETIC OUTFLOWS IN PRIMORDIAL STAR FORMATION <i>Jonathan C. Tan &amp; Eric G. Blackman</i>	401
THE SPACE DENSITY OF REDSHIFT 5.7 Ly $\alpha$ EMITTERS: FIRST CONSTRAINTS FROM A MULTISLIT WINDOWS SEARCH <i>Crystal L. Martin &amp; Marcin Sawicki</i>	414
DRAMATIC X-RAY SPECTRAL VARIABILITY OF THE BROAD ABSORPTION LINE QUASAR PG 2112+059 <i>S. C. Gallagher, W. N. Brandt, Beverley J. Wills, J. C. Charlton, G. Chartas, &amp; A. Laor</i>	425
X-RAY REFLECTION FROM INHOMOGENEOUS ACCRETION DISKS. I. TOY MODELS AND PHOTON BUBBLES <i>D. R. Ballantyne, N. J. Turner, &amp; O. M. Blaes</i>	436
A VIEW OF PKS 2155–304 WITH XMM-NEWTON REFLECTION GRATING SPECTROMETERS © <i>I. Cagnoni, F. Nicastro, L. Maraschi, A. Treves, &amp; F. Tavecchio</i>	449
A CHANDRA HETGS OBSERVATION OF THE NARROW-LINE SEYFERT 1 GALAXY ARAKELIAN 564 <i>Chiho Matsumoto, Karen M. Leighly, &amp; Herman L. Marshall</i>	456
PHYSICAL CONDITIONS IN THE NARROW-LINE REGION OF M51 <i>L. D. Bradley, M. E. Kaiser, &amp; W. A. Baun</i>	463
SUBMILLIMETER EMISSION FROM TYPE Ia SUPERNOVA HOST GALAXIES AT $z = 0.5$ <i>D. Farrah, M. Fox, M. Rowan-Robinson, D. Clements, &amp; J. Afonso</i>	489
MOLECULAR GAS IN CANDIDATE DOUBLE-BARRED GALAXIES. III. A LACK OF MOLECULAR GAS? <i>Glen R. Petitpas &amp; Christine D. Wilson</i>	495
THE RECENT CLUSTER FORMATION HISTORIES OF NGC 5253 AND NGC 3077: ENVIRONMENTAL IMPACT ON STAR FORMATION ©	503
THE ULTRALUMINOUS X-RAY SOURCE NGC 1313 X-2 (MS 0317.7–6647) AND ITS ENVIRONMENT © <i>Luca Zampieri, Paola Mucciarelli, Renato Falomo, Philip Kaaret, Rosanne Di Stefano, Roberto Turolla, Matteo Chierigato, &amp; Aldo Treves</i>	523
SPECTROPHOTOMETRY OF PLANETARY NEBULAE IN THE BULGE OF M31 <i>Martin M. Roth, Thomas Becker, Andreas Kelz, &amp; Jürgen Schmoll</i>	531
CHARACTERISTICS OF DIFFUSE X-RAY LINE EMISSION WITHIN 20 PARSECS OF THE GALACTIC CENTER <i>Sangwook Park, Michael P. Muno, Frederick K. Baganoff, Yoshitomo Maeda, Mark Morris, Christian Howard, Mark W. Bautz, &amp; Gordon P. Garmire</i>	548
1420 MHz CONTINUUM ABSORPTION TOWARD EXTRAGALACTIC SOURCES IN THE GALACTIC PLANE <i>S. Strasser &amp; A. R. Taylor</i>	560
THE NONLINEAR MAGNETIC CASCADE <i>Jason Maron, Steven Cowley, &amp; James McWilliams</i>	569
POLARIMETRY TOWARD THE MUSCA DARK CLOUD. I. THE CATALOG © <i>A. Pereyra &amp; A. M. Magalhães</i>	584
PROPER MOTION AND KINEMATICS OF THE ANSAE IN NGC 7009 <i>Rodrigo Fernández, Hektor Monteiro, &amp; Hugo E. Schwarz</i>	595
ANOMALOUS RADIO EMISSION FROM DUST IN THE HELIX <i>S. Casassus, A. C. S. Readhead, T. J. Pearson, L.-Å. Nyman, M. C. Shepherd, &amp; L. Bronfman</i>	599
NEUTRINOS AND NUCLEOSYNTHESIS IN GAMMA-RAY BURST ACCRETION DISKS © <i>Rebecca Surman &amp; Gail C. McLaughlin</i>	611
ANALYSIS METHODS AND RESULTS OF A SEARCH FOR WEAK GAMMA-RAY BURSTS IN THE BATSE DATA <i>I. G. Mitrofanov, D. S. Anfinov, M. S. Briggs, G. J. Fishman, R. M. Kippen, A. S. Kozyrev, M. L. Litvak, C. A. Meegan, W. S. Paciesas, R. D. Preece, &amp; A. B. Sanin</i>	624
CHANDRA ACIS AND XMM-NEWTON EPIC OBSERVATIONS OF THE X-RAY–LUMINOUS SN 1978K IN NGC 1313 <i>Eric M. Schlegel, Albert Kong, Philip Kaaret, Rosanne DiStefano, &amp; Steve Murray</i>	644

	<i>Page</i>
FORCE-FREE MAGNETOSPHERE OF AN ACCRETION DISK—BLACK HOLE SYSTEM. I. SCHWARZSCHILD GEOMETRY <i>Dmitri A. Uzdensky</i>	652
WHERE ARE THE Be/BLACK HOLE BINARIES? <i>Fan Zhang, X.-D. Li, &amp; Z.-R. Wang</i>	663
TIME DEPENDENCE IN RELATIVISTIC COLLISIONLESS SHOCKS: THEORY OF THE VARIABLE “WISPS” IN THE CRAB NEBULA © <i>Anatoly Spitkovsky &amp; Jonathan Arons</i>	669
THE BIG GLITCHER: THE ROTATION HISTORY OF PSR J0537–6910 <i>F. E. Marshall, E. V. Gotthelf, J. Middleditch, Q. D. Wang, &amp; W. Zhang</i>	682
GALACTIC POPULATIONS OF ULTRACOMPACT BINARIES <i>Krzysztof Belczynski &amp; Ronald E. Taam</i>	690
MAGNESIUM ISOTOPE RATIOS IN HYADES STARS <i>David Yong, David L. Lambert, Carlos Allende Prieto, &amp; Diane B. Paulson</i>	697
HE 0107–5240, A CHEMICALLY ANCIENT STAR. I. A DETAILED ABUNDANCE ANALYSIS © <i>N. Christlieb, B. Gustafsson, A. J. Korn, P. S. Barklem, T. C. Beers, M. S. Bessell, T. Karlsson, &amp; M. Mizuno-Wiedner</i>	708
OTHER KUIPER BELTS <i>M. Jura</i>	729
DUSTY DEBRIS DISKS AS SIGNPOSTS OF PLANETS: IMPLICATIONS FOR <i>SPITZER SPACE TELESCOPE</i> <i>B. Zuckerman &amp; Inseok Song</i>	738
LONG-TERM COSMIC-RAY MODULATION IN THE HELIOSPHERE <i>S. E. S. Ferreira &amp; M. S. Potgieter</i>	744
THE ROLE OF NONLINEAR COUPLING IN WAVE HEATING OF CORONAL LOOP <i>Q. Y. Luo, X. S. Feng, &amp; F. S. Wei</i>	753
ACTIVE REGION STREAMER DIAGNOSTICS 2001 SEPTEMBER 14–16 <i>M. Uzzo, Y.-K. Ko, &amp; J. C. Raymond</i>	760
TORSIONAL OSCILLATION, MERIDIONAL FLOWS, AND VORTICITY INFERRED IN THE UPPER CONVECTION ZONE OF THE SUN BY TIME-DISTANCE HELIOSEISMOLOGY <i>Junwei Zhao &amp; Alexander G. Kosovichev</i>	776
THE INFLUENCE OF VELOCITY SHEAR ON MAGNETIC BUOYANCY INSTABILITY IN THE SOLAR TACHOCLINE <i>S. M. Tobias &amp; D. W. Hughes</i>	785
ERRATUM: “HOW MANY ACTIVE GALAXIES & QSOS WILL FUTURE SPACE MISSIONS DETECT?” (ApJ, 597, 759 [2003]) <i>Paola Andreani, Luigi Spinoglio, &amp; Matthew A. Malkan</i>	803
ERRATUM: “NEW MEMBERS OF THE TW HYDRAE ASSOCIATION, $\beta$ PICTORIS MOVING GROUP, AND TUCANA/HOROLOGII ASSOCIATION” (ApJ, 599, 342 [2003]) <i>Inseok Song, B. Zuckerman, &amp; M. S. Bessell</i>	804

